The E-health Strategic Research Orientation at the Centre for Telematics and Information Technology

Manfred Reichert

Centre for Telematics and Information Technology (CTIT)
University of Twente, The Netherlands

m.u.reichert@cs.utwente.nl

1 Introduction

The continuously rising costs in healthcare, the growing size of the aged population who will need healthcare services, and the rise of expectations regarding the quality of healthcare services all create a high need for new approaches to reduce healthcare costs while maintaining or even increasing the level of service. At the same time recent developments provided by bio-, micro- and nano-technologies create new opportunities for realizing innovative healthcare services. By the use of these new technologies in healthcare different goals are in the focus: To decrease overall costs for healthcare, to improve healthcare quality, and to collect and consolidate patient-related information from different devices and sources. However, this raises many challenges ranging from core technical issues (e.g., secure integration and processing of medical data from small, unobtrusive devices) to the more application-oriented issues (e.g., realization of new healthcare services and treatment scenarios).

To actively contribute to these goals, the Centre for Telematics and Information Technology (CTIT) at the University of Twente has selected E-health as one of its strategic research orientations (SRO). The aim of this SRO is to investigate the use as well as the further development of advanced information and communication technology (ICT) in the healthcare chain. Obviously, this necessitates multidisciplinary research, which does not only consider technological issues but addresses legal and societal aspects, too.

So far, activities of the E-health SRO have been focused around topics like mobile health services, ambient computing, or IT support for healthcare processes. Considering the current trend towards miniaturization (e.g., realization of small, unobtrusive medical devices collecting data from a patient or medical implants supporting the medication of a patient) new challenges as well as new perspectives with respect to these topics arise. Researchers from the E-health SRO are aware of this fact and want to contribute to converge bio-, micro- and nano-technology towards integrated smart medical systems.

2 Participating Research Groups and Partners

Research activities of the E-health SRO have been interdisciplinary from the very beginning and has involved groups from different disciplines like Computer Science, Management Science, Mathematics, and Behavioral Sciences – an overview of the research groups currently participating in the SRO is depicted in Table 1.

In order to deal with the trends and challenges described in the introduction section, in future, partners with strong competence in bio-, micro- and nano-technologies will be involved in projects of the SRO as well. The overall objective is to contribute to the development of integrated bio-, micro- and nano systems in healthcare, and thus to enable innovative healthcare services.

EWI-ASNA	Architecture and Services of Network Applications
EWI-CADTES	Computer Architecture Design & Test for Embedded Systems
EWI-DIES	Distributed and Embedded Systems
EWI-HMI	Human Media Interaction
EWI-IS	Information Systems
EWI-SK	Statistics and Probability
EWI-SOR	Stochastic Operations Research
EWI-DMMP	Discrete Mathematics and Mathematical Programming
EWI-BSS	Biomedical Signals and Systems
BBT-OMPL	Operational Methods for Production and Logistics
BBT-ISCM	Information Systems & Change Management
BBT-CSST	Centre for Studies of Science, Technology and Society
BBT-STePHS	E-health Architecture and Standards (part of BBT/STePHS)

Table 1: Research groups participating in the E-health SRO (July 2006)

In their e-health related research projects these groups have already cooperated with partners from both industry and healthcare. Table 2 shows selected partners actively involved in current projects.

Partners from industry
Atos Origin, Ericsson, IBM, Lucent Technologies, Ortec, Philips Medical Systems, Philips Research, Roessingh R & D, Telematica Instituut, TNO, Twente Medical Systems International, Vodafone, Yucat
Partners from the healthcare domain
Amsterdam Medical Centre, Erasmus Medical Centre, ESG, Medisch Spectrum Twente, Hospital Clinic i Provincal de Barcelona (HCPB), Lito Polyclinic Paralimni LTD, University of Marburg (Medical Informatics Group)

Table 2: External research partners of the E-health SRO (July 2006)

Finally, the E-health SRO actively participates in several Dutch initiatives in the healthcare domain like, for example, the IZIT program of the Province of Overijssel, the Dutch HL7 group, and the ESIH group on emerging standards in healthcare.

3 Current and Future Research

The overall objective of the E-health SRO is to develop innovative ICT services for improved and integrated care. Along this line researchers of the E-health SRO cover various topics including telemedicine, smart medical surroundings, process and information management in healthcare, privacy and security in healthcare, bioinformatics, and user-centered design of healthcare ICT services.

Research is focused around four major themes: telemedicine and mobile health services, smart medical surroundings, optimization and IT support of healthcare processes, and bioinformatics. In the following we sketch related scenarios and relevant issues.

a) Telemedicine and Mobile Health Services

By 2020, roughly 25% of the population in the western world will be aged 60 or older. With age, we increasingly suffer from chronic health problems, that limit our activities in daily life. It is a challenge to use technology to support the quality of life of these chronically impaired people. Care for these persons is best provided in the home environment. Care is about quality of life, where cure is about saving life.

Chronically ill people, or those living with a condition that needs regular monitoring, are often limited and not free to do spontaneous things. Their regime is planned around hospital visits, check-ups and overnight stays. In many cases, patients feel insecure to be away from medical attention worrying that it is too risky for their health. The forthcoming availability of high bandwidth public wireless networks and emerging technologies for equipping people with sensors interconnected under a body area network will provide new opportunities to significantly improve this situation. In this context, SRO researchers have been developing new mobile healthcare services.

For example, these services enable the contactless monitoring of patients or the automatic detection of emergency situations. From the introduction of such services to practice we expect healthcare professionals to be able to remotely access, diagnose and treat patients whilst these patients will be free to continue with daily life.

b) Smart medical surroundings

Treatment procedures, which were previously confined to the hospital, will be more and more provided in the home environment. Accompanying to this trend, patients will become surrounded by “intelligent” electronic equipment that can satisfy information and communication needs on demand. Researchers from the E-health SRO investigate, define, and develop core architectures and frameworks for such ambient intelligent environments. This includes the development of new devices (sensors, actuators, special hardware) and networking capabilities (e.g. wireless), but also the more software-oriented and application-related issues (e.g., requirements engineering). A typical demonstration scenario that SRO researchers are working on is the provision of smart agents automa-

tically collecting patient data during homecare. Besides homecare there is a variety of other challenging application scenarios for smart health surroundings including well-being (sports and fitness) or the support of healthcare professionals in daily life.

In both areas – mobile healthcare services and smart medical surroundings – the E-health SRO does not only deal with issues related to core technology, but takes a business process viewpoint as well. The introduction of mobile devices in healthcare, for example, requires the solution of technical problems such as security, privacy, and reliability of services offered by those devices. However, these solutions can only work in practice if they align with the business processes employing these devices, and if these processes themselves are redesigned to work effectively with these devices. In this context one has to consider that the healthcare sector is characterized by complex, but nevertheless highly structured interactions between different user groups, including health care professionals (doctors and nurses), patients, vendors of medical technology and medical information systems, and health insurance companies. A thorough understanding of these interactions is needed to anticipate the factors that facilitate or complicate the acceptance of potential negative attitudes towards the new technology. (In the past many of the new innovations in the healthcare sector failed because user needs had not been taken into account!).

Even more ambitious is the introduction of ambient technology such as wireless body area networks for health monitoring. Apart from the difficult technical problems in making these devices communicate securely and reliably, we need to redesign health care procedures to work effectively with them. Moreover we must align these devices and procedures with the patients' way of living as well. Though Smart medical surroundings are user-centered technologies, no systematic research has been done on the preferences and skills of users in the healthcare sector with respect to this new technology. Again this necessitates multi-disciplinary research to investigate and assess the needs and interests of the different stakeholders and users in the healthcare sector.

Another challenging issue concerns the integration of medical data produced or consumed by respective devices. Integrating data, devices and the services provided by them is a difficult task, as individual systems have been usually not designed to cooperate. In particular, respective solutions are often based on differing conceptualizations of the application domain, which are not necessarily compatible. Today powerful integration tools (e.g. different kinds of message-oriented middleware) are available to overcome technical and syntactical heterogeneity of autonomous system components (e.g., medical devices). Yet, semantic heterogeneity remains as a major barrier to seamless integration of autonomously developed software devices and smart medical systems.

c) Optimization and IT support of processes in healthcare

Providing healthcare increasingly changes from isolated treatment episodes towards a continuous treatment process involving multiple healthcare professionals and various institutions. For integrated care, process and information management play a crucial role in this interdisciplinary process.

In particular, patient treatment requires the cooperation of various healthcare providers and medical disciplines. Thus optimized and coordinated process support play a crucial role in healthcare in order to improve the quality of patient treatment and to decrease

costs. Groups from the E-health SRO work on different topics related to healthcare processes. One focus is put on the provision of methods and models for process and resource optimization. This includes, for example, support for the planning, scheduling and benchmarking of operating theatres or for the simulation of emergency scenarios. Another focus is on the IT support of patient treatment processes in both healthcare organizations and healthcare networks. Topics of interest include the implementation of medical guidelines and clinical pathways, the realization of lifetime patient records, the provision of patient information and medical knowledge at the point of care, the evolution of healthcare standards, and privacy and security issues.

d) Bioinformatics

Bioinformatics will open new opportunities for healthcare as well. For example, the SRO participates in a project whose aim is to process bio-information from data to knowledge in such a way that its dissemination will provide enabling technologies and innovative methods to a multitude of educational, research-related and developmental life science applications (like, for example, the provision of new lab tests in healthcare).

Table 3 shows selected projects in which groups from the E-health SRO are currently involved.

Project Name	Funding Organization
HealthService 24 – Continuous mobile services for healthcare	EU / eTen
Biorange – A research program to shape the future for bioinformatics in the Netherlands	Bsik
Privacy and the dynamics of network technologies in the healthcare sector	NWO Netwerk voor Netwerken
PROSE – Process Support in Healthcare	NWO Hefboom
NFU Operating Room benchmarking project	NFU and all 8 Dutch Academic hospitals
Smart Surroundings, WP Interfaces & Interaction / Setting	Bsik Smart Surroundings (since 2004)
Privacy and the dynamics of network technologies in the healthcare sector	NWO Netwerk voor Netwerken
Multi-modal Visualization Environment for Interactive Analysis of Medical Data	NOW
MinADEPT – Mining of adaptive healthcare processes	NWO Open Competition
AWARENESS – Context AWARE mobile Networks and ServiceS / Personal Treatment Services	Bsik Freeband (since 2004)

Table 3: Selected Projects of the E-health SRO started in 2004 or 2005

4 Summary and Outlook

Supporting the quality of daily life of patients can be approached in two ways. One is to use technology to restore lost or damaged function (e.g., provide an electrical stimulator to a paralyzed person). The other is to adapt the environment of the client, so that the loss of a function does not create a problem anymore. This has traditionally been the domain of rehabilitation, where assistive technologies have been used in these two approaches.

The second approach would fit ideally in a smart medical surroundings initiative. There is the challenge in designing new mobile healthcare services and smart medical surroundings technologies that can support the quality of life of chronically impaired citizens in a modern affluent information society. These citizens don't want a computer on their table. They want their problems being alleviated with technologies that seamlessly fit in their daily environment and daily tasks. In this context we could build on the experience obtained in rehabilitation. There we see the difficulties of using technologies in this area. Roughly 30-50% of technologies prescribed have been abandoned by the users after some time. This is a shameful waste of resources - something is going terrible wrong in the design and/or prescription process. Therefore assessment of user needs and fears must be an important part of any research in this context.

Furthermore, chronically impaired people all have specific individual problems. It is not trivial to design a platform technology that can be tailored to the needs of the individual client. Care is something that cannot be provided by machines - interaction with people is vital. This means that innovative care services will need to be developed that provide added value over what we have until now.

There are ethical questions as well. We should take care that technology does not create social isolation of people who are already vulnerable in this respect. Ideally, this technology should support social and societal participation. Surely ICT has the potential to do this, we "only" have to exploit this potential.

The Symposium on Integrated Micro Nano Systems, which was organized in June 2006 at the University of Twente, brought together researchers from the University of Twente which are working in different disciplines and different institutes: CTIT (Centre for Telematics and Information Technology), MESA+ (Institute for Nanotechnology) and BMT (Institute for BioMedical Technology). The symposium has raised many R&D challenges and has given insights into new solutions for next generation application services and products based on bio-, miro- and nano-technologies. From the different presentations it has become obvious that healthcare constitutes a key application in this context, if not even the killer application for these new technologies. However, future innovation and progress necessitates a closer cooperation between these groups and the further strengthening of multidisciplinary research. The three institutes (CTIT, MESA+ and BMT) therefore agreed to explore collaboration and to organize follow up events in future.